

IT IS CLAIMED:

1. A method of machining a braking surface to be frictionally engaged with a brake pad for enhancing braking strength, better adaptation to working site conditions, and length of service life by ultrasonic oscillations applied to rework a previously machined braking surface presenting a working surface having tooling marks and exhibiting tensile stress, comprising the steps of: impacting said machined braking surface with ultrasonic oscillations developed in a coordinated set of individual impacting elements ultrasonically driven by an ultrasonic transducer to induce on and beneath said work surface a modified work surface layer smoothing and hardening the braking surface to produce a longer wearing and stronger braking surface, said oscillations being of sufficient intensity to effect surface and sub-surface plastic deformation resulting in removal of the tooling marks thereby producing at said braking surface a smoothed plastic deformation surface having improved frictional abutment properties for engagement with a brake pad while reducing scuffing and heat checking under conditions of dry sliding contact and frictional loading with a surface of the brake pad and presenting a strengthened braking surface extending operating life of the braking surface.

2. The method of Claim 1 wherein said machined braking surface is upon a rotatable surface, comprising the steps of subjecting the rotatable surface to controlled application of ultrasonic oscillation energy applied to machine the braking surface by ultrasonic transducer means driving a set of individual oscillating indenters into contact with the braking surface, and relatively scanning the transducer means and rotatable surface to uniformly establish a deformed braking surface.

3. The method of Claim 2, wherein said braking surface is a cast iron brake drum interior circumferential surface, and said transducer means is attached to a lathe unit positioned inside the drum to contact said set of indenters with the braking surface, and wherein said indenters and the interior circumferential surface are relatively rotated by said lathe unit.

4. The method of Claim 1 wherein said plastic deformation results in an ultrasonically machined braking surface presenting an average surface roughness not greater than 200 micro-inches.

5. The method of Claim 1 wherein said impacting elements have an oscillating amplitude between 10 and 50 microns.

6. The method of Claim 1 further comprising the step of driving the impacting elements into the braking surface at a

duty cycle of not more than 25% of operating time of the ultrasonic transducer.

7. The method of Claim 1 further comprising the step of operating the ultrasonically driven impacting elements at a resonant oscillation frequency of up to 100 kHz.

8. The method of Claim 1 wherein the impacting elements have a mass between 1.5 g and 20 g.

9. The method of Claim 1 further comprising pressing the impacting tool impacting elements against the work surface with an adjustable force above 0 and up to 50 kg with an oscillation amplitude sufficient for uniformly introducing plastic deformation of the braking surface and adjacent sub-surface region to produce a smoothed braking contact surface structure.

10. The method of Claim 1 including the step of resiliently pressing the impacting tool indenter elements against the work surface by a resilient member disposed in the ultrasonic transducer.

11. The method of Claim 2 wherein the impacting elements of said set are positioned to contact said interior braking surface at an angle to normal of a magnitude maintaining indenter vibration stability and preventing withdrawal of the tool from the work surface at a specified tool travel speed along the work surface during rotation.

12. The method of Claim 11, wherein said angle is substantially 19 degrees and a travel speed of relative movement of the tool and the work surface is in the vicinity of 190 RPM as effected with a vertical boring and turning lathe.

13. The method of Claim 1 wherein the ultrasonic impact energy applied to said work surface provides by plastic deformation a surface roughness not greater than 200 micro-inches.

14. The method of Claim 1 wherein the impacting elements present an oscillation amplitude at the work surface ranging from between 0 and 100 microns.

15. The method of Claim 1 further comprising the step of moving the impacting elements in the set freely in random axial motion between an oscillating surface on said ultrasonic transducer and the braking surface.

16. The method of Claim 1 further comprising the step of driving the impacting elements into said braking surface at a velocity high enough to exceed the yield point of the braking surface thereby to compress a layer on the braking surface.

17. The ultrasonic impact machining method of machining a braking surface adapted to frictionally contact a brake shoe, said braking surface initially presenting tooling marks exhibiting residual roughness patterns and surface tensile stresses, comprising the steps of: generating surface and sub-surface molten plastic deformation of a work surface on the

braking surface from ultrasonic oscillation energy to produce a modified smoothed braking surface having improved frictional abutment properties upon engagement with a brake pad friction surface thereby to reduce scuffing and heat checking under conditions of dry sliding contact and frictional loading upon braking contact with a brake pad.

18. The method of Claim 17 further comprising the step of machining said braking surface with a set of ultrasonically vibrated indenter needles disposed to freely axially move in response to impact by an ultrasonic transducer so that the individual indenter needles of the set strike the braking surface and rebound in a random pattern.

19. The method of Claim 17 further comprising the step of machining the braking surface at ambient temperature.

20. The method of Claim 17 further comprising the step of generating a compressed braking surface deformation that increases the braking strength capability of the braking surface.

21. An ultrasonic tool system for machining and re-processing a metallic frictional braking surface of a metallic braking rotor presenting residual tensile stresses and an indented tooled surface structure, comprising an ultrasonic transducer driving a set of freely axially movable indenters for impacting the braking surface ultrasonically by energy transfer from said transducer to thereby induce surface and sub-surface

plastic deformation smoothing said indented tooled surface structure thereby producing a braking surface with increased interfacing area exhibiting greater surface strength and surface scanning means for relative movement between the indenters and the frictional braking surface of the braking rotor.

22. The ultrasonic tool system of Claim 21 wherein said scanning means further comprises lathe means presenting said impacting tool with said indenters in place for impact with the machined surface of the rotor and relatively rotating the indenters and said rotor.

23. The ultrasonic tool system of Claim 21 wherein the impacting tool is angled from the normal of the frictional braking surface at an angle for maintaining tool vibration stability and maintaining the tool in working relationship with the frictional surface at a designated travel speed of the tool relative to the brake rotor during ultrasonic impact machining of said surface.

24. The ultrasonic tool system of Claim 22 wherein said lathe means comprises a vertical boring and turning machine.

25. The ultrasonic tool system of Claim 21 wherein said ultrasonic transducer comprises a tuned damper operable at a natural mechanical frequency in a frequency range up to 3 kHz for energizing a set of indenters having natural resonance frequencies up to 300 kHz.

26. The ultrasonic tool system of Claim 25 wherein the tuned damper comprises a spiral spring.

27. An ultrasonic impact tool system for treating and re-processing a metallic machined frictional braking surface of a metallic braking rotor presenting residual tensile stresses and an indented tooled surface structure, comprising an impacting tool having an ultrasonic transducer, and a set of freely axially movable indenters driven by said transducer for impacting a work surface comprising said machined frictional braking surface ultrasonically at frequencies up to 55 kHz by energy from said transducer to thereby induce a surface layer of plastically deformed material with increased wear resistance properties while replacing said indented tooled surface structure with a smoothed frictional abutment surface structure for engagement with brake pad frictional surfaces under conditions of dry sliding contact with and frictional loading by brake pad surfaces.

28. The impact tool system of Claim 27 further comprising a positioning and scanning system placing said transducer and indenters into a scanning position adjacent the braking surface for uniformly processing the entire braking surface.

29. The impact tool system of Claim 28 wherein the positioning and scanning system comprises a lathe which presents the transducer in an interior cylindrical cavity of a cast iron

brake drum.

30. The impact tool system of Claim 27 wherein the ultrasonic transducer and the indenters are mechanically tuned to produce a Q-factor of the order of 800.

31. An improved reworked metallic braking rotor having a braking surface adapted to engage a brake pad in dry sliding contact and frictional loading characterized in an initial manufacturing process by presence of residual tensile stresses and tooling mark indentations in said braking surface comprising:

an ultrasonically reworked braking rotor presenting a smoothed plastically deformed braking surface introducing increased braking surface contact area.

32. The braking rotor of Claim 31 further comprising a compressed sub-surface layer on the braking surface establishing increased wear resistance properties.

33. The braking rotor of Claim 32 further comprising a depth of said compressed sub-surface layer exceeding the limits of braking wear depth.

34. The braking rotor of Claim 31 wherein said reworked rotor surface further comprises a machined surface established by ultrasonic impact machining with a set of individual randomly ultrasonically driven indenter elements.

35. The braking rotor of Claim 31 wherein the smoothed plastically deformed braking surface has a roughness not

exceeding 200 micro-inches.

36. The braking rotor of Claim 31 wherein said reworked rotor surface is an interior cylindrical surface of a brake drum which has been ultrasonically machined.

37. An ultrasonically reworked metallic braking rotor having a plastically deformed, smoothed and compressed braking surface.

38. The reworked braking rotor of Claim 37 comprising a cast iron brake drum with an internally disposed cylindrical braking surface.

39. The reworked braking rotor of Claim 37 having a surface roughness of less than 200 micro-inches.

40. The reworked braking rotor of Claim 37 presenting a uniform stress profile under the braking surface to a depth of 12 mm, thereby ensuring uniform deformation eliminating stress concentration at the surface and reducing possibility of crack development.

41. The reworked braking surface of Claim 37 presenting a cast iron braking surface with a strength exceeding the yield point of the cast iron.

42. The reworked braking surface of Claim 37 presenting a surface of higher contact area for abutment with the brake lining.

43. The reworked braking surface of Claim 37 having a smoother surface finish with better contact surface area with the applied brake lining during operation resulting in less heat

build up during brake application, more efficient braking and safer application of the brake.

44. A method of ultrasonically reworking a metallic braking rotor surface disposed upon a rotor body with ultrasonic energy to produce a compressive work surface strength of said rotor surface exceeding the yield point of the rotor body to approach the maximum strength of the rotor body.

45. The method of Claim 44 wherein the rotor surface is an interior cylindrical surface of a brake drum.